

PROPOSALS FOR LAND TREATMENT OF SECONDARY SEWAGE
EFFLUENT FOR LITCHFIELD, CONNECTICUT
(A Pilot Demonstration Project)

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PROPOSAL FOR LAND TREATMENT OF WASTEWATER EFFLUENTS

A. PURPOSE

The purpose of this proposal was to identify plausible land oriented treatment systems by which secondary sewage effluent could receive additional treatment, while encouraging agricultural pursuits and maintaining open areas. Described are conceptual plans for three possible land treatment systems which serve to display additional planning requirements and estimated construction cost for each system. Implementation of either land system at Litchfield, Conn. would serve as a pilot project, demonstrating land treatment in southern New England. This proposal was developed to satisfy interest indicated by members of the U. S. Environmental Protection Agency, the U. S. Army Corps of Engineers and local and regional officials of the Litchfield area. Estimates for planning needs and cost are included.

B. DURATION AND FUNDING OF PRELIMINARY PLANNING EFFORT

Completion of the proposed preliminary planning effort would result in the selection of a technically viable land treatment alternative at a reasonable cost which would be acceptable by local, state and federal agencies. The costs associated with this planning effort are estimated at about \$150,000. Phased funding could be undertaken as follows to coincide with data collection, alternatives formulation and plan recommendation:

- a. Initial funding of \$75,000 to initiate contractual arrangements for field investigation and laboratory work, preliminary planning and coordination which would be conducted throughout the study.
- b. Mid-stage funding of \$50,000 to complete field investigation, array preliminary plans, coordinate with local, state and federal agencies.
- c. Final funding of \$25,000 to complete all contractual arrangements, finalize planning efforts, array recommended plan and complete the report.

Duration of the proposed planning effort is estimated at 9 - 12 months and initial funds after authorizations are received, with field investigations being conducted during May-September 1975.

C. INTRODUCTION

The national objective to clean up and maintain our environment has made people realize that municipal and industrial wastes can no longer be dumped indiscriminately into our lakes, streams and groundwater aquifers. Dumping raw or inadequately treated wastes to our water resources by individuals or communities results in the tainting and degradation of water supplies available to other individuals. Discharging effluents from adequate secondary treatment facilities which will have sufficient nutrients can lead to the rapid and excessive aquatic plant growth which in turn degrades the quality of surface water.

The soil has long been known as an effective decontaminating system. Dead animals, plant material and animal manures, including human excrement, have long been spread and worked into soils from time immemorial. In this manner, plant nutrients have been recycled, essential soil micro-organisms fed and soil structure maintained or improved. It has been essential that these waste additions not be excessive, in order that the renovation capability of the plant-soil system was not exceeded.

Treatment of municipal and industrial wastes in facilities constructed explicitly for this purpose are utilized by some New England communities. These "secondary" treatment facilities remove settleable solids and oxidize organic matter and nitrogenous compounds. Removal of nutrients and very stable organics, as well as soluble cations and ions, require additional treatment methodologies.

Alternative to conventional treatment facilities to further purify wastewater effluent is that of using the vegetative-soil ecosystem with crop production and harvesting. Growing crops on land irrigated with sewage effluents, will enable wastewater nutrients to be immediately cycled into food production, while stable organics and cations contained in the wastewater effluent are removed by the soil exchange complex.

Every state allows waste treatment using the land by permitting the use of the universal land treatment system; the domestic septic tank and leach field. Larger land treatment operations for renovating

municipal and industrial wastewaters have been practiced many years in California, Texas, Arizona and Pennsylvania (8). Large elaborate spray irrigation systems for treatment of substantial quantities of municipal and industrial wastewaters are exemplified by systems at Pennsylvania State University (4), the Muskegon, Michigan project and the Gray Farm in Lubbock, Texas (3). Wastewater renovation in these projects is an integral part of the agricultural operation, by which nutrients and water are supplied for crop growth. The Santee project in California (6), the Rio-Salata project in Phoenix, Arizona (1) typify rapid infiltration treatment facilities and urban use of reclaimed water (1, 6).

Land treatment methodologies proposed here utilize the soil-biological system to further renovate secondary treated wastewater. Since abiotic and biotic processes differ in intensity between various soils, the land treatment method considered and the management procedures used must be carefully selected for the site and contemplated land treatment approach to ensure acceptable wastewater renovation is achieved and adverse impacts are minimized.

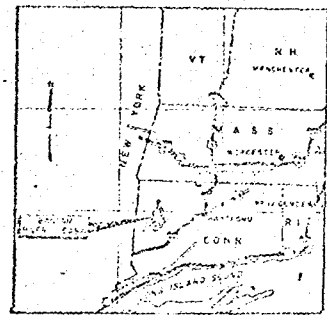
D. OBJECTIVES

Municipal and industrial wastewater flows from Litchfield, Conn. are presently treated in a conventional secondary activated sludge treatment facility with disinfected effluent being directly discharged into the Bantam River. Enactment of more stringent water quality criteria for effluents discharged to surface streams in Connecticut, will require additional treatment before wastewater effluents are discharged to the Bantam River from the Litchfield treatment facility.

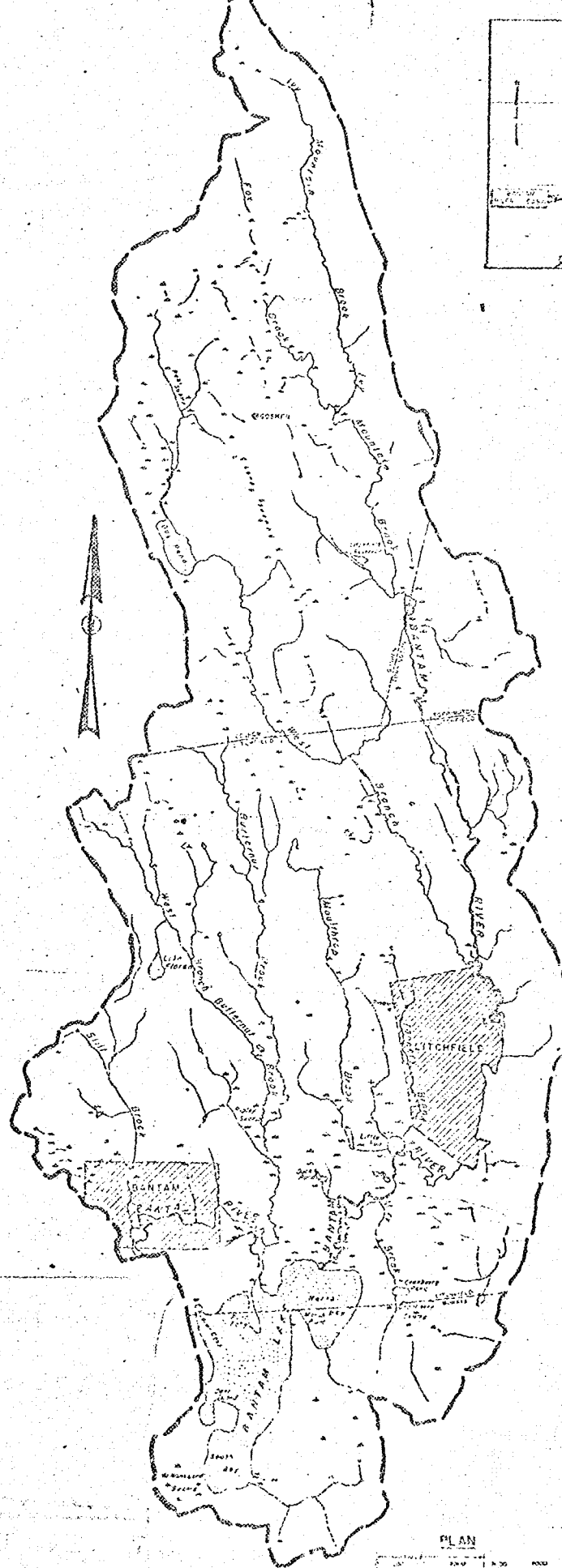
The purpose of this proposal is to (1) identify potential wastewater management alternatives which incorporate natural processes of the soil-vegetative complex to achieve renovation of wastewater effluents while maintaining open space, encouraging agricultural pursuits and enhancing water quality in the Bantam River, and (2) identify potential areas requiring investigation prior to alternative selection.

E. DESCRIPTION OF THE STUDY AREA

The study area primarily involves Litchfield, Conn. and adjacent portion of Morris, Conn. Litchfield is located in western Connecticut,



LOCATION MAP
SCALE IN MILES



STATE OF CONNECTICUT	
WATER RESOURCES COMMISSION	
WILLIAM S. HILL, DIRECTOR	
LITCHFIELD COUNTY	
DANBURY RIVER	
WATERSHED MAP	
1. Danbury River 2. Danbury Reservoir 3. Danbury Dam 4. Danbury Reservoir 5. Danbury Dam 6. Danbury Reservoir 7. Danbury Dam 8. Danbury Reservoir 9. Danbury Dam 10. Danbury Reservoir	1. Danbury River 2. Danbury Reservoir 3. Danbury Dam 4. Danbury Reservoir 5. Danbury Dam 6. Danbury Reservoir 7. Danbury Dam 8. Danbury Reservoir 9. Danbury Dam 10. Danbury Reservoir

PLAN

approximately 16 miles northwest of Waterbury, Conn. and 33 miles west of Hartford. Litchfield is more or less gently rolling land with hills rising 50 to 300 feet above adjacent valleys. Drum-loid hills trending slightly west of north are prominent features, particularly around Bantam Lake and in the northeast and southeast corners of the town. The town lies partially within the Bantam River drainage basin which is bounded on the west by the Shepaug River and on the east by the Naugatuck River. The watershed is elongated in a north-south direction for a length of about 15 miles and an average width of less than four miles. The main river, fed by numerous streams, flows in a southerly direction for most of its length to Bantam Lake. From this location, the river flows generally in a southwesterly direction to its confluence with the Shepaug River, approximately six miles downstream of Bantam Lake.

Bantam Lake which lies in the Towns of Morris and Litchfield, is part of the geological flood plain on the Bantam River. The lake acts as a natural retarding basin for approximately 40 square miles of watershed measured at its outlet. At a normal elevation of 894^{ft}/msl, Bantam Lake has a surface area of about 950 acres (1.5 square miles). About 400 summer cottages and permanent homes are located along its shoreline.

The outflow from the lake to Bantam River passes through a flat, meandering stream and then converges rapidly into a narrow channel. Discharge relationships developed for Bantam River at the outlet of Bantam Lake, under present conditions are given in Table 1.

The climate of the Bantam River watershed is typical of the Berkshire region of New England. A variable climate, it is characterized by frequent periods of heavy precipitation produced by local thunderstorms and frontal storm systems. Frontal storm systems usually originate over western United States or southwest Canada and cross the basin in an easterly or northeasterly direction.

Tropical storms and northeast storms which form off the coast of the Carolinas, travel up the Atlantic Seaboard to Connecticut and occasionally attain hurricane intensity in the late summer and autumn months. The proximity of the Atlantic Ocean constitutes an important modifying factor on the climate relative to extremes, but does not dominate it.

TABLE 1

DISCHARGE-FREQUENCY DATABANTAM LAKE AT MORRIS-LITCHFIELD CONN.

(DA = 40 sq. mi.)

(Measured at Lake Outlet)

<u>Frequency</u> (% chance of occurrence)	<u>Discharge</u> (c. f. s.)	<u>MGD</u>
1.0	2,000	1,293
1.3	1,850	1,196
5.0	1,550	1,002
20.0	1,200	776
50.0	950	614
100.0	700	452

Average annual temperature of the Bantam River Basin is about 47°F (Table 2). Average monthly temperatures vary widely throughout the year, ranging between 65°F and 70°F over the basin in June through August to between 24°F and 30°F in December through February. Extremes in temperature range from occasional highs of 100°F to lows of minus 27°F. Freezing temperatures may be expected from the latter part of October until late April. The mean, maximum and minimum monthly and annual temperatures recorded at Shepaug Dam and Cream Hill are shown in Table 2.

The mean annual precipitation over the Bantam River Basin is about 46 inches and is uniformly distributed throughout the year. Extremes in yearly total precipitation have ranged from more than 66 inches to less than 30 inches. Monthly totals have similarly varied from less than 0.2 inch to more than 19 inches. The mean, maximum and minimum monthly plus the annual recorded precipitation at Cream Hill and Shepaug Dam are summarized in Table 3.

The average annual snowfall over the Bantam River Basin ranges from 50 to 70 inches. Mean monthly snowfall and annual accumulation at Collinsville and Cream Hill are shown in Table 4. Collinsville, having an elevation of 280 feet (MSL) and Cream Hill having an elevation of 1,300 feet (MSL) are considered representative of the basin. Snowcover reaches a maximum depth in late March and has a water content in early spring of four to six inches.

Soils in the general area of the treatment facility have developed in glacial till or glacial outwashed stratified sands and gravels. Upland soils belong predominantly to Paxton and Charlton soil series with small areas of other soil series (Birdstall, Holli, Leicester, Pudunk, Raynham, Ridgebury, Suttery, Tisbury, Sudbury and Woodbridge) intermingled. Soils in the area west of the Litchfield treatment facility are Hinckley and Merrimack soils which have developed stratified sands and gravels.

F. EXISTING SEWAGE TREATMENT FACILITY

The existing sewage treatment facility for Litchfield, Conn., which includes the boroughs of Litchfield and Bantam, Conn., is a conventional activated sludge secondary treatment facility, which was constructed in 1971. A schematic of the facility is shown in Figure 2.

TABLE 2

MONTHLY TEMPERATURE
(Degrees Fahrenheit)

Cream Hill
El. 1300 feet M.S.L.
74 Years Record

Shepaug Dam
El. 840 feet M.S.L.
22 Years Record

<u>Month</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
January	23.8	70	-19	24.1	61	-27
February	24.2	68	-23	26.5	62	-17
March	33.1	82	-10	33.7	75	-11
April	44.5	86	10	46.6	88	8
May	55.9	92	23	56.1	91	24
June	64.8	98	32	65.2	92	36
July	69.6	98	41	69.6	94	43
August	67.6	98	37	67.8	96	33
September	61.2	98	26	60.9	95	29
October	51.1	89	15	51.7	85	20
November	38.7	77	- 5	40.7	73	10
December	26.8	67	-22	28.9	64	-13
Annual	46.8	98	-23	47.7	96	-27

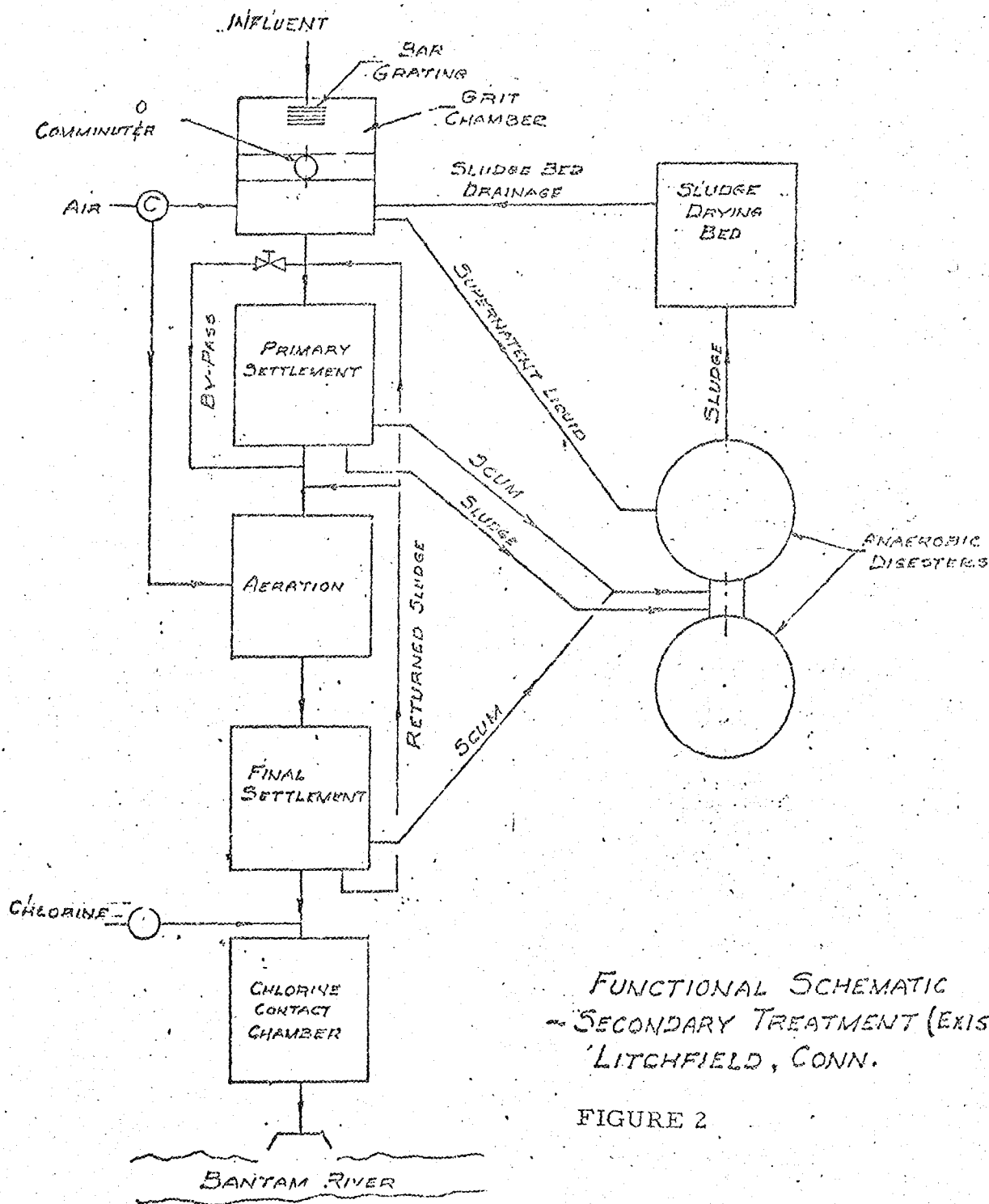
TABLE 3

MONTHLY PRECIPITATION
(in Inches)

Cream Hill El. 1,300 feet M.S.L. 73 Years Record				Shepaug Dam El. 840 feet M.S.L. 22 Years Record		
<u>Month</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
January	3.34	7.64	.51	3.22	6.72	.39
February	3.13	6.51	.81	3.21	4.80	.99
March	3.57	8.01	.29	3.77	10.31	1.26
April	3.60	7.65	.84	4.15	7.21	1.06
May	3.80	7.06	.95	3.53	6.69	.97
June	4.22	10.05	.89	4.02	8.64	1.72
July	4.46	9.71	1.15	3.64	8.05	1.33
August	4.13	18.54	.87	4.12	19.70	1.26
September	4.13	13.03	.63	3.72	8.01	1.98
October	3.35	11.75	.22	3.51	13.42	.19
November	3.76	9.25	.25	4.49	7.55	2.08
December	3.57	9.52	.98	4.47	8.71	.76
Annual	45.06	64.26	28.11	45.85	66.13	30.58

TABLE 4
MEAN MONTHLY SNOW FALL

	Cream Hill, CT El. 1,300 feet M.S.L. 72 Years Record	Collinsville, CT El. 280 feet M.S.L. 33 Years Record
<u>Month</u>	<u>Snow Fall</u>	<u>Snow Fall</u>
January	17.1	14.2
February	17.7	14.0
March	13.8	9.1
April	5.0	1.4
May	.03	T
June	—	T
July	—	—
August	—	—
September	—	—
October	0.20	T
November	5.7	3.0
December	13.4	8.7
Annual	72.9	50.4



FUNCTIONAL SCHEMATIC
- SECONDARY TREATMENT (EXISTS)
' LITCHFIELD, CONN.

FIGURE 2

The facility was designed for a 1990 flow of 0.78 mgd, with peak flow of 2.67 mgd (Table 5) (5). Influent flows, larger than peak flow design, have resulted because of substantial infiltration to sewer lines. Hourly flows have varied 0.2 - 2.0* mgd, with higher estimates being made.

Daily wastewater flows to the treatment facility have been quite variable. Average daily flow in 1972 and 1973 were about 0.55 and 0.49 mgd, respectively. However, daily flows in 1972 ranged 0.42 - 1.74 mgd, and in 1973 flow ranged 0.32 - 1.90 mgd. Hourly peak flows have been in excess of 2.0 mgd which appears to be the capacity of the metering device.

Estimates of the population served by the treatment facility was 3,700 for 1970 and was expected to increase to 7,000 in 1990 and 12,000 in 2020 (5). Future flows above the design flow will be accommodated by modular expansion of the existing treatment facility.

TABLE 5
POPULATION PROJECTIONS AND WASTEWATER
FLOWS TO LITCHFIELD SEWAGE TREATMENT FACILITY a/

	YEAR			
	1965	1970	1990	2020
Total Population	7,180	9,000	13,500	20,000
Sewered Population	2,260	3,700	6,950	12,000
Average daily flow (mgd)	0.25	0.35	0.78	1.37
Peak hourly flow (mgd)	1.70		2.67	4.03

a/ Ref. 5

Quality of effluent from the secondary treatment facility is approximated by data presented in Table 6. Chlorine is added to the effluent prior to discharge to the Bantam River to kill susceptible pathogenic organisms. Chlorine residual in effluent on August 1974 was approximately 3.0 mg/l.

TABLE 6

Chemical Characteristics of Secondary Effluent-Litchfield, Conn.

Parameter ^{a/}	April 73 ^{b/}	August 74 ^{c/}	Sept 74 ^{c/}
pH (standard units)	7.3	6.4	-
Conductivity	- ^{d/}	575	490
Alkalinity (mg/l as CaCO ₃)	98	69	60
COD	-	50	20
BOD	3.7	-	1.2
Total nitrogen	12	16.4	11.4
Organic nitrogen	1.0	0.4	0.2
NH ₄ -N	4.0	0.02	0.2
NO ₃ -N	7	16	11
NO ₂ -N	0.02	-	-
Total PO ₄ -P	-	12	7
Ortho PO ₄ -P	-	12	4
Chlorides	47	230	260
Residual chlorine	-	3.0	-
Sulfate	-	58	47
Ca	-	93	38
Mg	-	11	12
K	-	28	24
Zn	-	6	0.03
Cd	-	ND ^{e/}	ND
Cu	-	ND	ND
Al	-	ND	ND
Ba	-	ND	-

a - mg/l unless otherwise indicated

b - Analysis by Connecticut State Department of Health, April, 1973.

c - Analysis by Corps of Engineers, Water Quality Laboratory New England Division.

d - Analysis not performed

e - Concentration less than detection levels

G. PROPOSALS

Treatment of municipal wastewater flows for Litchfield, Conn. is currently accomplished by conventional activated sludge secondary treatment.

During precipitation periods or instances of stormwater surface runoff, wastewater flows at the treatment facility generally exceed the "normal" operating capacity (0.8 mgd) of the facility. During these instances, wastewater treatment is reduced proportionately with decreased retention time in the treatment units. To achieve more equitable treatment and presumably a more constant effluent quality, peak flows would be collected in an equalization lagoon, then subsequently bled to the treatment facility during low flow periods.

Effluent from the secondary treatment facility would be stored in a lagoon, from which water would be pumped to land application sites for additional renovation using soil-vegetative complex. Three alternatives are proposed for land treatment of secondary effluent:

1. Spray irrigation of effluent to the land over the entire year -- Spray irrigation during the growth season would be to crop and forage crops and to forested land during winter period.
2. Spray irrigation to forage and cropland during the growth season. During the non-growing season, effluent would be stored in surface lagoons.
3. Wastewater effluents would be applied to crop and forage land by spray irrigation during the growth season. During non-growing season and during periods of high peak flows, wastewater effluent would be treated using rapid infiltration/percolation.

Basically these alternatives differ in the manner which effluent flows will be handled during inclement weather or non-growing periods. Additional consideration must be given to nutrient budgets for each alternative, and anticipated land requirements for treatment of wastewater flows for the year 2020.

Equilizing Peak Flow

Critical to design and operation of conventional wastewater treatment facilities are wastewater flow data and flow projections.

Available data from the existing Litchfield treatment system show quite variable wastewater flows both daily and seasonally. Attenuation of peak flows can be accomplished either prior to conventional secondary treatment in equalization ponds or following treatment in storage lagoons. Of paramount importance, however, is the resultant effluent quality to be applied to the land and the anticipation of other considerations such as nutrient and other organic constituents. Proposed plan to control of peak flows is shown schematically in Figure 3.

Wastewater inflow above the design capacity of the treatment facility would be diverted to an equalization pond after passing through a degritting chamber and comminutor. Size of the pond would vary accordingly to projected peak daily wastewater flow. It is assumed the lagoon would have an eight-foot effective depth. Using flow projections for 1990 and 2020, the areal extent of the surface lagoon equalization pond was calculated. Equalization pond for 1990 and 2020 was sized using projected max. hourly flows of 1.9mgd and 2.7 mgd respectively.

The 7-day capacity was founded on 1972 and 1973 flow records which show several occasions during which wastewater flows exceeded design capacity of the treatment facility for three-five days. To ensure sufficient holding capacity while ponded wastewater is bled to the treatment system, a 7-day capacity was selected. Size of the lagoon for 1990 flows would be about 5.0 acres and for 2020 flows 7.1 ac.

These estimates are reasonable but must be re-evaluated as more definitive flow data becomes available.

Proposed Land Treatment Sites

Land believed suitable for spray irrigation are presently found in the general area east of Bantam Lake in the Towns of Litchfield and Morris, Conn. (Figure 4). Preliminary site investigation using soil survey information (2) and U. S. G. S. quadrangle sheets show some 960 acres suitable for spray irrigation. This acreage includes both the application area and 250-foot buffer strip around the application sites.

Initial phased implementation of any proposed land system would not require the total acreage indicated, however, some commitment towards the total area may be needed to ensure availability to handle for 2020 flows.

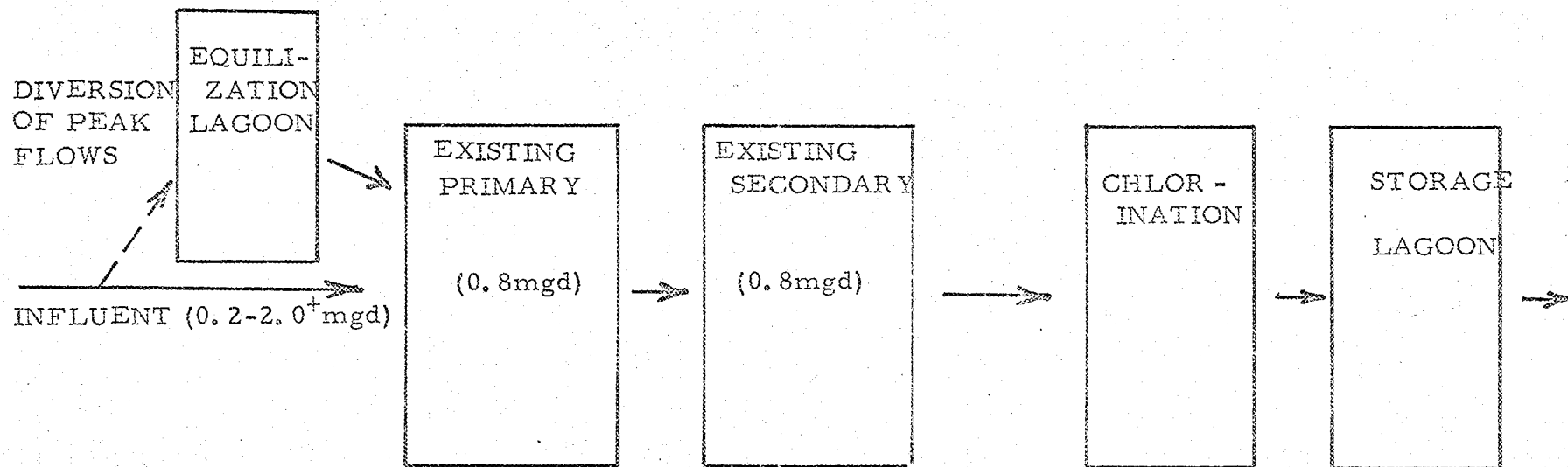
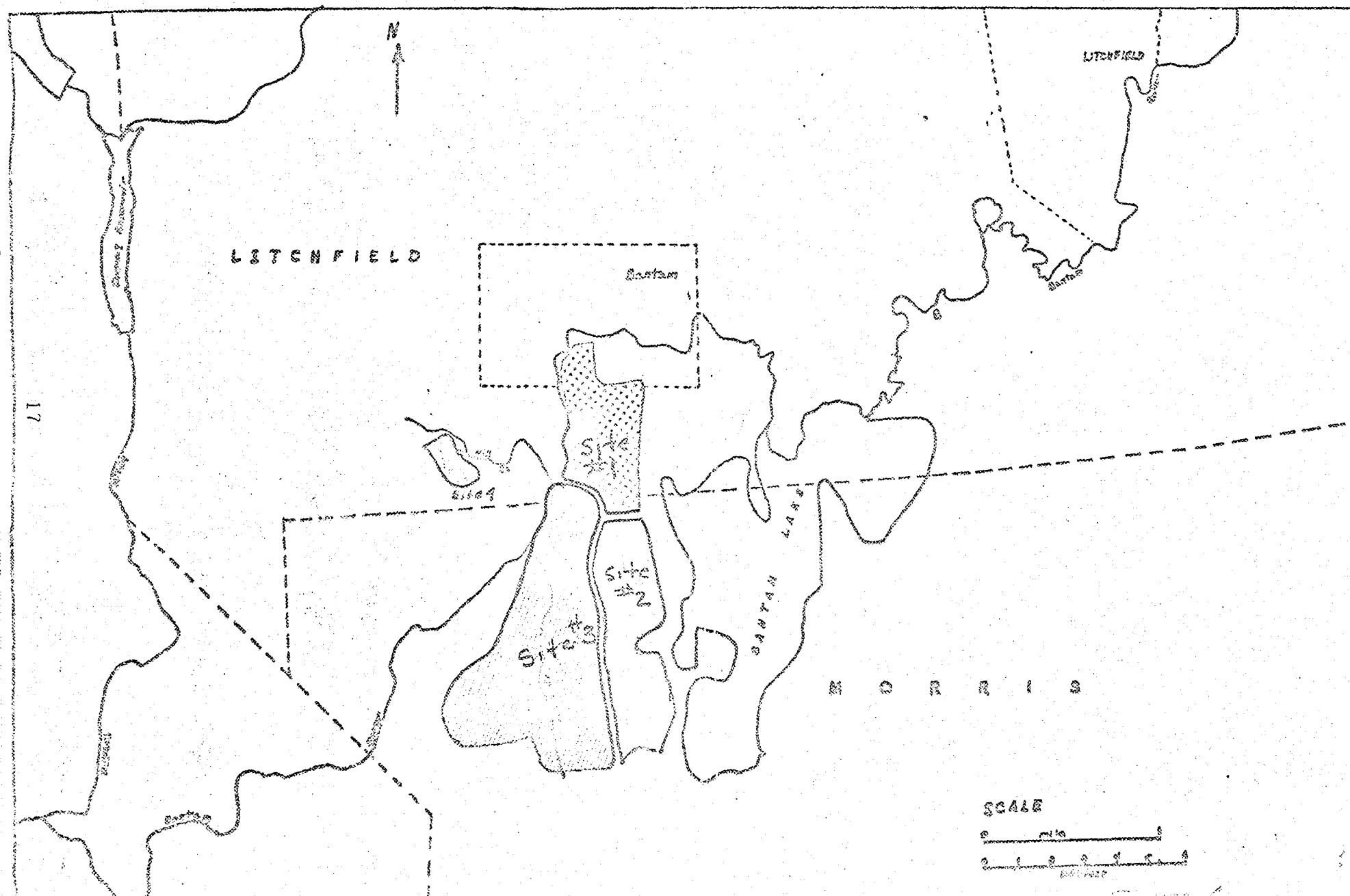


FIGURE 3. PROPOSED PLAN TO EQUILIZE INFLUENT FLOWS.



Potential application area was divided into four parcels for discussion. Numerical ordering of each site was for conveyance and does not show preference.

Proposed Site 1: This area is adjacent to and east of the existing Litchfield wastewater treatment facility. Somewhat rectangular in shape, the site is about 5,000 feet long and 2,500 feet wide. Elevation above mean sea level (msl) at the treatment facility is 780 feet increasing to 940 feet on the east side of the site along state highway #209. The site is approximately 190 acres of which about 115 acres could be used for spray irrigation. About half of the area is currently used for agricultural pursuits, while the remainder is in various stages of re-forestation. Single family housing development has occurred along the northern and east edges of the proposed site. Recently, several single family dwellings have been built along the southern edge of the site.

Proposed Site 2: Site 2 lies entirely within the Town of Morris, Conn., approximately 2,500 feet south of the Litchfield wastewater treatment facility. The elongated site, approximately 7,000 feet in length and 2,000 feet in width, encompasses some 230 acres of which about 110 acres are believed suitable for spray irrigation. Site is bordered on the east by State Highway #209 which skirts the western shore of Bantam Lake and on the west by Morris Hill Road. No Man's Land Swamp lies along the southern edge and secondary road runs along the northern parameter. Elevation at the northern border is about 900 feet or 110 feet higher than the sewage treatment facility. From the northern edge, land surface slopes upward to an elevation of 1010 feet in the southern portion of the site. Here the land slopes towards No Man's Land Swamp (elevation 900 feet).

Presently, approximately half of the proposed 230 acres are open and agricultural land and half is forested land. Some single family development are present along Route 209 and eastern edge of the proposed site.

Proposed Site 3: Site 3 consists of approximately 540 acres of which some 385 acres are believed suitable for implementing spray irrigation of secondary effluents. The site is bisected by Bizzell Brook which flows in a northerly direction then joins the Bantam River. A buffer strip will be needed around Bizzell Brook. The site

is bordered along on all sides by state secondary roads; to the north and east by Morris Hill Road, to the south and west by Bantam River and Kenyon Road.

The proposed site is located approximately 1,800 feet from the existing Litchfield treatment facility. The site is about 9,000 feet in north-south direction and averages about 3,500 feet in east-west direction.

Elevations range from about 750 feet along the Bantam River along the northern edge and to about 990 feet in the south-east corner of the site. Land on the site is about equal agricultural land and forested land. Some single family dwellings are found along the secondary road which forms the western border of the proposed site.

Proposed Site 4: Land treatment methodology contemplated for this area is the implementation of rapid infiltration-percolation system. The area consisting of some 50 acres located approximately 3,500 feet southwest of the existing Litchfield secondary treatment facility. The site is bounded to the west by a powerline right-of-way, to the north and east by Hill Brook and to the south highland associated with Looking Glass Hill. Presently, the land is completely forested and will require site preparation. To obtain the required acreage and slope, a rough estimate shows about 32,000 cu. yd. of material must be excavated. The excavate can be used for fill along the northern edge of the site. Water from the treatment site would recharge Hill Brook which joins the Bantam River downstream from the existing treatment facility.

Proposed Land Treatment Alternatives

The land-oriented alternatives proposed for additional effluent renovation, emphasizes spray irrigation where water and nutrients inputs can be effectively used for crop production. Alternatives 1 and 2 consider spray irrigation explicitly as the means to apply effluent to the land. Differences between the two alternatives exist in management considerations and their associated cost. Alternative 1 uses cropland during the growing season and forested land in the winter. Alternative 2 entails spray irrigation only during the growth season and lagooning during colder periods of the year. Alternative 3 differs from number 1 and 2 in that another mode of land treatment,

rapid infiltration, is considered in lieu of winter spray irrigation or lagooning. Land requirements and cost associated with each alternative for the 1990 and 2020 design years were determined.

Alternative 1

Alternative 1 is shown schematically in Figure 5. Land treatment for secondary effluents in this alternative would be accomplished by spray irrigation to cropland during mid-April through mid-October and to forested lands during mid-October through mid-April. Application rate would be two inches of effluent per week to both cropland and forested land. However, effluent quality may necessitate some adjustment. Initially, crops grown would be cool season grasses. This would increase the number of days during which effluent application would be carried out on cropland. Consideration for planting corn or other row crops in application areas should be addressed.

Based upon a 1990 design flow of 0.8 mgd and 2020 design flow of 1.4 mgd, the storage lagoon and land application areas for this alternative were determined. Storage lagoon would have an effective depth of eight feet and sufficient size to contain the average daily flow for seven consecutive days. This should provide flexibility in system operation during period of inclement weather. Summary of the land requirements for this proposed concept are shown below.

	<u>1990</u>	<u>2020</u>
Storage lagoon (7 days)	2.7 ac	4.7 ac
Summer application (cropland)	104 ac	182 ac
Winter application (forested land)	<u>104 ac</u>	<u>182 ac</u>
Total Acreage	210.7 ac	368.7 ac

These figures do not include land requirements for the 250-foot wide buffer strip around application area.

Alternative 2

Alternative 2 is comparable to the summer operation visualized for alternative 1 (Figure 6). Site characteristics, application rate, crops and cropping procedure would be identical to alternative 1. Rather than operate the system in forest areas from mid-October to mid-April, wastewater flows would be stored in surface lagoons.

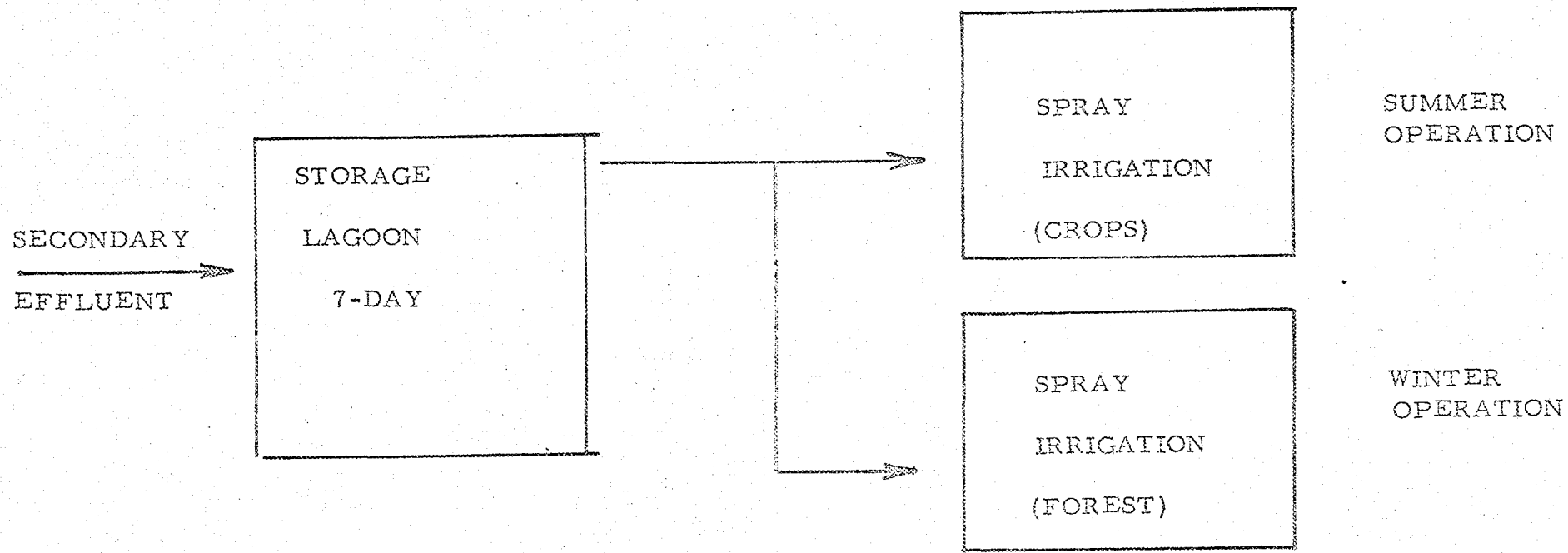


FIGURE 5. LAND TREATMENT ALTERNATIVE 1

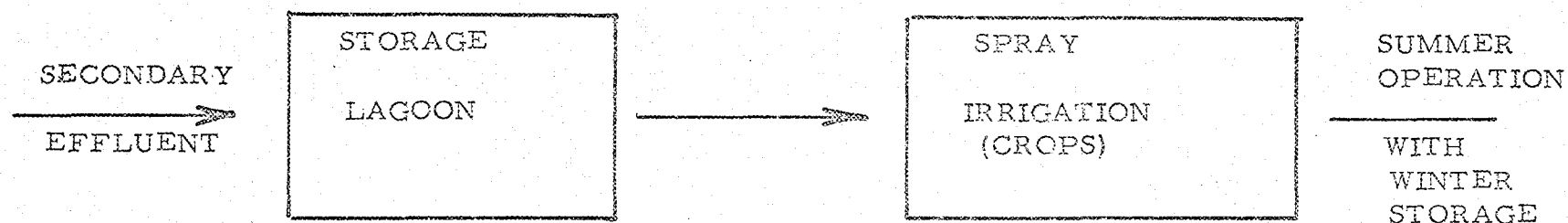


FIGURE 6. LAND TREATMENT ALTERNATIVE 2.

Size of the storage lagoon would be approximately 28 acres for 1990 flows and 50 acres of projected 2020 flows. The lagoon would have an effective depth of 20 feet and would provide storage for 210 days of effluent flow plus the net annual precipitation falling on the lagoon.

Acreages needed for spray irrigation of stored water at two inches per week during 155 days would be about 257 acres for projected 1990 flows and 450 acres for 2020 flows. These numbers do not include acreages for the 250-foot buffer strip around the spray irrigation sites.

Summary of the land areas needed for this alternative are:

	<u>1990</u>	<u>2020</u>
Storage lagoon (210 days)	28 ac	50 ac
Application area (155 days)	<u>257 ac</u>	<u>450 ac</u>
Total Acreage	285 ac	500 ac

Alternative 3

Alternative 3 differs from the other alternatives in that land treatment using infiltration/percolation is proposed for effluent treatment during non-growing periods (Figure 7). Effluent flows would be treated during the growing season by spray application to cropland. During inclement weather, crop harvesting, or the non-growing season, effluent flows would be treated using rapid infiltration.

Effluent flows would be stabilized during spray irrigation periods in a surface storage lagoon. Effective depth of the lagoon would be eight feet and would have sufficient capacity to hold seven days effluent flow. Acreage for the storage lagoon would be about 2.6 acres for 1990 flows (0.8 mgd) and 4.7 ac for 2020 flows (1.4 mgd).

Spray irrigation of effluents would be at rate of two inches per week during the 155-day crop growing season. Acreages required to handle the projected 1990 flows would be 104 acres and for 2020 flows, 182 acres.

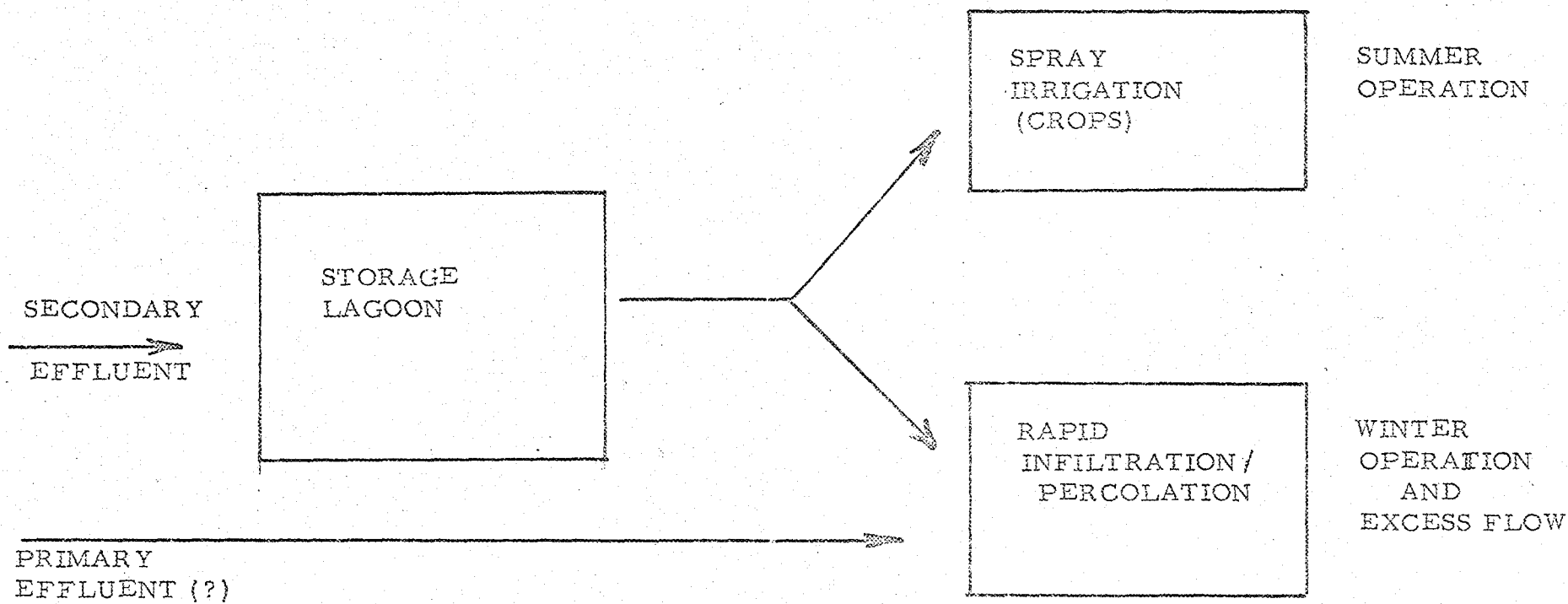


FIGURE 7. LAND TREATMENT ALTERNATIVE #3

These figures do not include acreage for the 250-foot buffer strip around the spray application areas.

During non-growing periods, effluent treatment using rapid infiltration/percolation is proposed.

Land required for rapid infiltration depends upon operation cycle, application rate and design flow. Connecticut Department of Health specified open sewage treatment beds should operate at application rate not greater than 100,000 gallon per acre per day or about 2.3 gal/ft²/day. Based upon operation experience in other New England areas (7) the initial operation cycle of the treatment beds would be three days inundation followed by 15 days recovery period. Land required for the 1990 flows would be about six acres and 2020 flows about 16 acres. These acreages would be increased slightly by inclusion of associated berm and border areas.

Summary of land area required are:

	1990	2020
Storage lagoon (7 days flow)	2.6 ac	4.7 ac
Spray irrigation (summer operation)	104 ac	182 ac
Rapid infiltration/percolation (winter operation)	6 ac	16 ac
Total Area	112.6 ac	202.7 ac

H. FUTURE PLANNING

Before decisions can be made concerning the desirability of each proposed alternative, additional information must be obtained to ensure each land treatment system present is implementable. Available site and wastewater flow data have shown three land orientated wastewater treatment systems are indeed plausible, however, detailed planning must be initiated in order to formulate more explicit alternatives for selection. To achieve this objective, a two-phase planning effort is proposed: Preliminary planning to compile pertinent data concerning each proposal phase addition. Engineering design and costs for each alternative.

Compilation of additional information was broken down in the following work items:

- a. Institutional arrangements would array various alternatives for land acquisition, cost-sharing for future operation and maintenance, and responsibility for future operation and maintenance.
- b. Site investigation require the major effort during this planning phase. Efforts would include: detailed soil surveys, geologic investigation, hydrologic evaluation of surface and subsurface water movement, drainage requirements, nutrient budgets, formulation of agricultural practices and hygienic aspects of the proposed systems.
- c. Wastewater flows and quality during the calendar year would be characterized to facilitate design and costing of proposed land systems. Wastewater inputs and proper operation of land system must be conducted in view of capability of the land system to assimilate the constituent impacts.
- d. Infiltration to the collection system would be evaluated beyond that currently completed to distinguish between direct inflow and infiltration with recommendations for immediate action.
- e. Final formulation of alternatives based upon information compiled from institutional studies and site investigations. Basic criteria and required facilities for each land treatment system would be finalized.

f. Preliminary engineering design and cost for proposed systems would be made in sufficient detail to permit decision-making for selecting the alternative for final design.

Cost for preliminary planning was estimated at about \$151,000 for the preliminary planning. This estimate cost of each major work item is as follows:

- a. Institutional arrangements (\$10,000)
- b. Site investigations (\$80,000)
- c. Wastewater flows and effluent quality (\$7,000)
- d. Infiltration evaluation (\$3,000)
- e. Final formulation of alternatives (\$15,000)
- f. Preliminary engineering design and cost of each alternative (\$36,000)
- g. Administration (\$25,000)

I. COSTS

Construction costs associated with three proposed alternatives are shown in Table 7. These costs are for facilities which included dual pumping units and stand-by power necessary to handle projected 1990 and 2020 flows.

Table 7

PRELIMINARY ESTIMATED TOTAL CONSTRUCTION COSTS (cost in \$1000's)

Item	ALTERNATIVE					
	1		2		3	
	1990	2020	1990	2020	1990	2020
Equalization Facilities	\$ 110.0	\$ 152.0	\$ 110.0	\$ 152.0	\$ 110.0	\$ 152.0
Effluent Pumping Facilities	139.0	127.0	139.0	127.0	139.0	127.0
Land Application Facilities	1,405.0	2417.0	3310.0	5942.0	991.0	1541.0
Estimated Construction Cost	\$1,654.0	\$2696.0	\$3559.0	\$6221.0	\$1240.0	\$1820.0
Contingencies (20%)	331.0	539.0	712.0	1244.0	248.0	364.0
Engineering and Design (5%)	99.5	162.0	213.5	373.5	74.5	109.0
Supv. and Admin. (5%)	99.5	162.0	213.5	373.5	74.5	109.0
Total	\$2,184.0	\$3559.0	\$4698.0	\$8212.0	\$1637.0	\$2402.0

Preliminary cost data in Table 7 show larger effluent flows will require bigger facilities to handle the flows and consequently result in higher costs. Estimated costs for either design year show alternative 3 to be least costly, followed by alternative 1 and then alternative 2, which was most costly. Cost differences between alternatives were those associated with large lagoon for winter storage and larger spray irrigation areas.

J. SUMMARY

Three land treatment alternatives were proposed which use the soil-vegetative ecosystem to achieve greater degree of wastewater renovation beyond that accomplished in conventional activated sludge secondary treatment.

Three alternatives differ in land requirements and approach to achieve renovation during the non-growing season. Alternative 1 would achieve year-round renovation through spray irrigation to cropland during the growing season and to forested land during the winter months. Alternative 2 entailed spray irrigation to cropland during growth season, however, wastewater flows during the winter effluent would be stored in surface lagoons. Alternative 3 would use year-round land application but incorporates rapid infiltration/percolation as the land treatment mode for winter operation. During growing seasons, spray irrigation to cropland would be practiced.

Preliminary cost estimates for the construction of facilities for each alternative shows alternate 3 the least costly and alternate 2 the most expensive. Major difference in costs are those associated with large storage lagoon and larger spray irrigation areas.

Recommendations for additional data acquisition, investigation and design were also identified.

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Back Up Cost Breakout

Cost Summary

A.	Institutional	\$ 10,000
B.	Site Investigations	80,000
C.	Wastewater/Effluent	7,000
D.	Infiltration	3,000
E.	Formulation	15,000
F.	Engineering (Preliminary)	36,000
		<u>\$ 151,000</u>

A.	Institutional Arrangements	est.	\$ 10,000
B.	Site Investigations		
1.	Detail Soil Survey		
	High level SCS soil survey in proposed sites Identify - soil series;		
2.	Soil Analysis - pH, CEC, N, P, K, Ca, Mg, Na, B (50 copies) (5 depths) = 250 samples @ \$60 ea	\$	15,000
	PSA - 250 samples \$5 ea	\$	1,250
3.	Borings		
	SI Site - 100 borings (20 ft ea)(\$6/ft) =	\$	12,000
	RI Site - 10 borings (100 ft ea)(\$14/ft) =	\$	14,000
4.	Percolation Test		
	Hydraulic conductivities 20 test @ \$125 ea =	\$	2,500
5.	Geologic Investigations		
	Groundwater and geology summaries	\$	5,000
6.	Summary Soil Data	\$	5,000
7.	Drainage Requirements		
	Computer work	\$	5,000
	Design	\$	5,000

8.	Agricultural Formulation	
	Cropping, nutrient inputs, water inputs	\$ 10,000
	Hygienic assessment	\$ 5,000
C.	Wastewater Flows and Effluent Quality	
1.	Flows	
	Evaluation flow records 6wk @ \$500/wk =	\$ 3,000
	Monitor flows (equipment) =	\$ 4,000
2.	Effluent Quality	
	pH, electrical conductivity, R-N, NH ₄ -N,	
	NO ₃ , Cl, PO ₄ -P (total and ortho) Ca, Mg,	
	Na, K, B, Cu, BOD, COD	
	24 hour composite samples (bi-weekly)	
	26 samples @ \$100/sample = \$2,600	
3.	Quantity effluent Quality =	<u>\$ 400</u>
		\$ 3,000
D.	Infiltration Evaluation	
1.	Field Observation During Precip. Events	
	20 man days @ \$150/day	\$ 3,000
E.	Formulation of Alternative	
	100 man days @ \$150/day	\$ 15,000
F.	Engineering Costs/Evaluation	
	200 man days @ \$150/day	\$ 30,000
	TOTAL	\$ 151,000
	Say	\$ 150,000
G.	Administration and overhead (13.27%)	<u>24,000</u>
	Grand Total	175,000